Space Weather Technical Forecast

Issued on Wednesday, 22 March 2023 at 12:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares. G1-G2 Minor/Moderate storms likely with coronal hole enhancement and possible combined CME arrivals, mainly day 2 (23rd). Active Electron fluence likely by day 4 (25th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with the largest flare an impulsive C4.6 at 21/1354 UTC from AR3257 in the southeast disc. There are now six sunspot regions on the disc, five of which are numbered. Four of the regions, including the more significant spot groups, are located in the southeast quadrant. AR3257 has maintained its two large constituent spot regions, but the small, weak delta spot appears to have now decayed. There is little discernible change in the other larger region, AR3256, which maintains a large lead spot. Remaining regions are relatively small and simple. A new region on the southeast limb, has the potential to reveal more complexity as it moves into a less oblique viewing angle.

There are a number of filaments on the Earth-facing disc, and these have been the source of a few CMEs when they lift. These have generally been off the Earth-Sun line with no Earth-directed CMEs observed in the last 24 hours. However a mixture of SOHO manoeuvres and STEREO A being used for non-operational activity results in limited availability of imagery, and low confidence for the CME analysis.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured at L1 showed the likely influence of the fast wind of CH85/+, rising from around 450km/s to 550 km/s through the period. The density was at mostly average levels but with a slow rising trend, becoming slightly above average with peak 13ppcc. The total IMF strength Bt, was weak to moderate, between 5-10nT, and on a slow declining trend, with the north-south component, Bz ranging from -7 to +9 nT. The phi angle remained predominately positive (away from the Sun). Geomagnetic activity was Quiet to Active (Kp 1-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 is now close to background levels. The high energy electron flux (greater than 2MeV) has generally been Background to Moderate with peak flux of 428 pfu. The associated 24-hour Electron fluence remained below the Active (1e8 integrated pfu) threshold. At 22/0000 UTC the observed fluence was 7.57e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low Solar activity is expected, with a chance of isolated Moderate flares. The main flare risk is currently from the more complex region in the southeast disc, AR3257, or from any of the regions rotating onto the disc form the far-side.

Solar Wind / Geomagnetic Activity: The CME as a result of the coronal dimming off the southwest disc on the 20 March has a low chance of glancing Earth early on day 2 (23rd). A second CME from the northeast filament eruption on the 20 March may give a glancing arrival

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around midday on day 2. Otherwise current elevated winds from CH85 are expected to ease slightly day 1 (22nd) before a transition into a stronger fast wind region from CH86/- day 2 (23rd), potentially preceded by a notable CIR region. These elevated winds are expected to continue day 3 (24th), perhaps easing day 4 (25th).

Geomagnetic activity is expected to be Quiet with Unsettled intervals for much of day 1 (22nd). During day 2 (23rd), the combined effect of CME arrivals and CH86/- enhancement is expected to increase activity to Unsettled to Active, with G1/Minor Storm intervals likely. There is a slight chance of G2/Moderate storms, should these CME and coronal hole sources enhancements align. Any enhanced activity is likely to continue day 3 (24th), but gradually easing back to mainly Quiet to Unsettled intervals by day 4 (25th).

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to continue close to background, with only a very slight chance of further enhancements should any significant flares occur. The high energy (greater than 2 MeV) electron flux is expected to persist largely at background days 1 to 2 (22nd-23rd) before likely rising day 3 (24th) to Moderate and then High by day 4 (25th). The associated 24 hour fluence is expected to remain below the Active threshold for much of the period, but with a chance of rising above by day 4.

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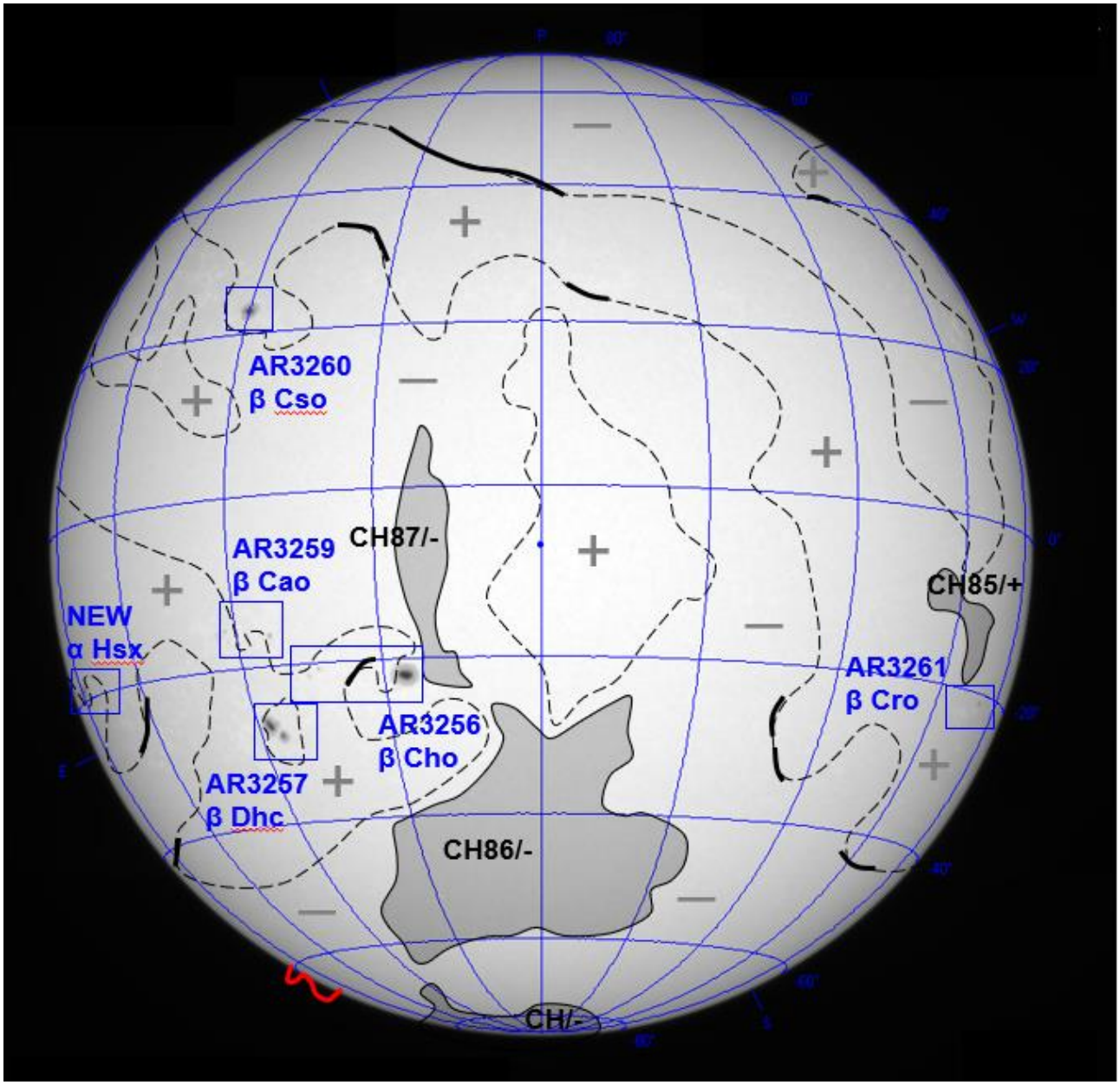
Figure 1. Solar Analysis Valid 22/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs that may give a glancing impacts at Earth, however these assessments carry low confidence due to the reduced imagery as a result of both SOHO LASCO and STEREO A having reduced operational availability.

The first was observed on the 20th, leaving the SW disc as a result of a broad coronal reconfiguration. The signal in coronagraph imagery was weak resulting in low confidence in analysis, but has chance of giving a glancing impact during the early hours of day 2 (23rd). The second is from a filament eruption in the northwest disc on the 20th, forecast to reach Earth's orbit around midday on day 2 (23rd). Minimal impact is expected, with much of the material passing north and behind Earth.

Current elevated solar winds, due to CH85/+ fast winds are expected to ease slightly day 1 (22nd). CH86/- is then expected to follow this, most likely on day 3 (23rd). As a persistent and clearly defined feature, a strong enhancement is expected, with winds reaching 600-700 km/s, and likely preceded by a relatively strong CIR region. These fast winds are then expected to persist into day 3 (24th), only easing day 4 (25th).

Geomagnetic activity is expected to be Quiet with Unsettled intervals for much of day 1 (22nd). During day 2 (23rd), the combined effect of CME arrivals and CH86/- enhancement is expected to increase activity to Unsettled to Active, with G1/Minor Storm intervals likely. There is a slight chance of G2/Moderate storms, should these CME and coronal hole sources enhancements align. Any enhanced activity is likely to continue day 3 (24th), but gradually easing back to mainly Quiet to Unsettled intervals by day 4 (25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	70	40	5
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0810	Partial	Coronal dimming	SW	602	23/0100	Possible glancing impact. Low confidence.
20/1905	Partial	Filament	NE	815	23/1100	As above

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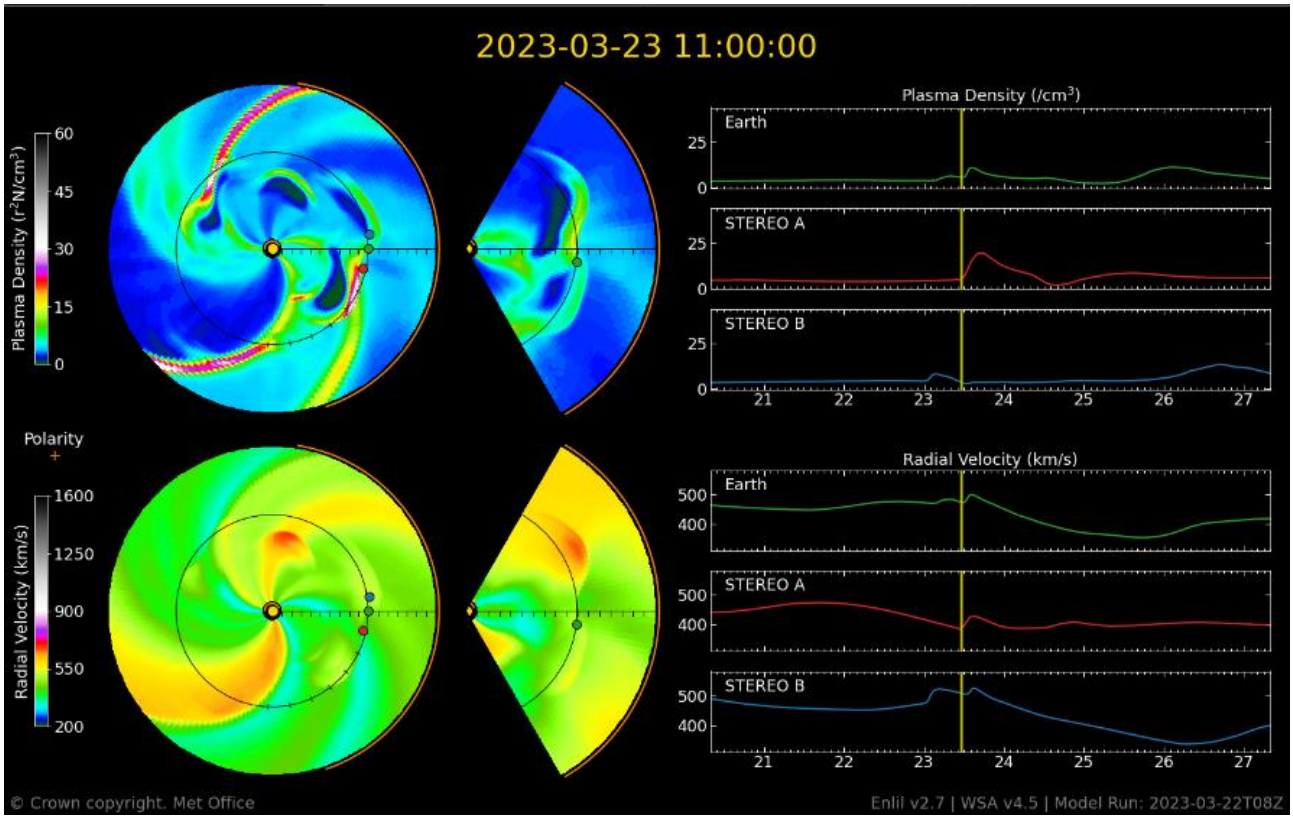
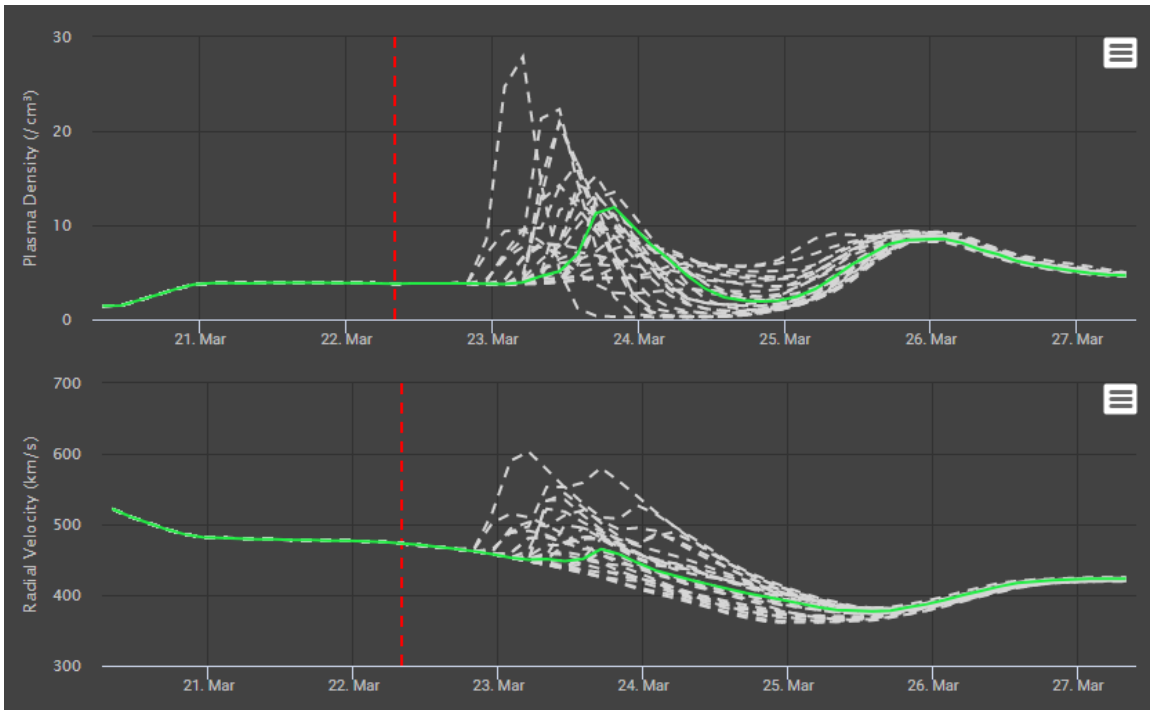
Figure 2: Enlil and Ensemble showing potential CME glances.





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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Generally Low Solar activity is expected, with a chance of rising to Moderate with isolated M-flares.

There are now six sunspot regions on the disc, five of which are numbered. Four of the regions, including the more significant spot groups, are located in the southeast quadrant. AR3257 has maintained its two large constituent spot regions, but the small, weak delta spot appears to have now decayed. There is little discernible change in the other larger region, AR3256, which maintains a large lead spot. Other regions are relatively small and simple. A new region on the southeast limb, has the potential to reveal more complexity as it moves into a less oblique viewing angle.

Bright flux on STEREO A euvi suggests that further complexity may rotate onto the disc, following this region. A similar bright flux signal is also present on the northeast limb, suggestive of a further region likely to rotate onto the disc here. Either of these could increase the potential for significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES-16 is now close to background. There is a very slight chance of further enhancements, due to the increased flare risk from the sunspot groups in the eastern disc. While not favoured for a strong connection, any significant flares will bring a very slight chance of flux levels rising towards the S1 Minor Radiation storm level.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	2	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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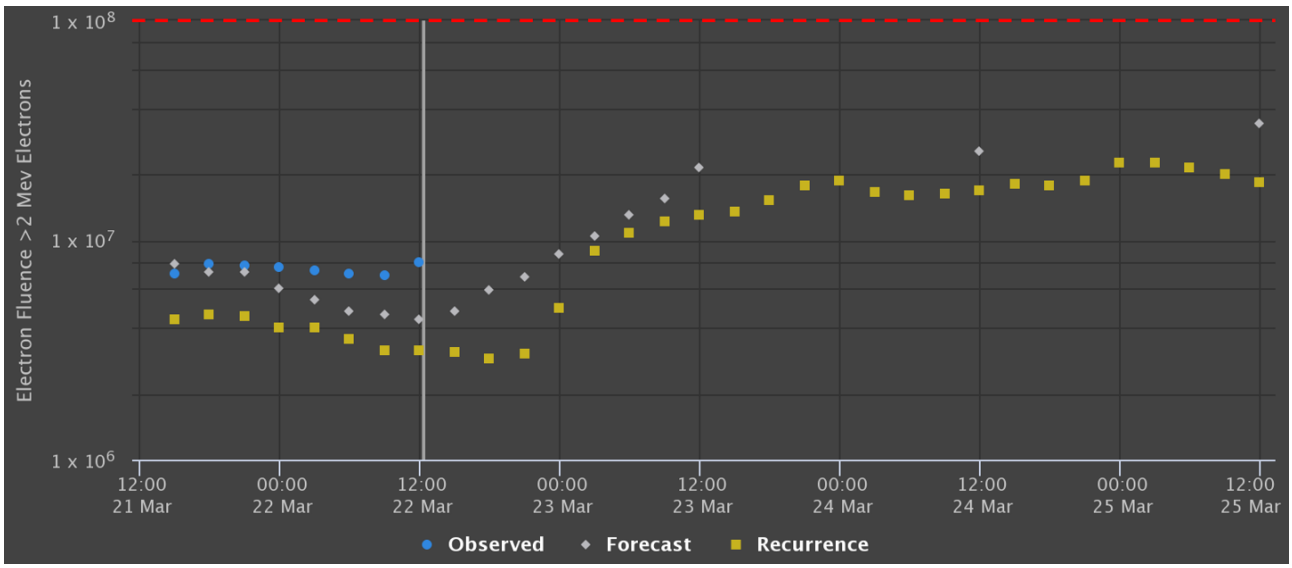
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux observed by GOES-16 is expected to be mainly background to Moderate days 1 and 2 (22nd and 23rd) with any enhancement from the fast wind arrival of CH85 likely to be limited. A more significant enhancement is expected from CH86 on day 2 (23rd). Coupled with potential CME arrivals, this will initially result in a dropout of values, before flux likely rises later that day, or more likely through day 3 (24th). By day 4 (25th) High levels are likely.

The associated 24 hour fluence is expected to be below the Active (1e8 integrate pfu) level through days 1-2 (22nd and 23rd) with REFM currently giving good guidance for this period. Fluence levels are then expected to rise through day 3 (24th), likely reaching the Active levels day 4 (25th).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	30	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	5

Figure 3: MOSWOC REFM



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